Module 2: Traffic Forecasting Methodologies
Module 1: Traffic Forecasting
Background
Policy, Administrative and Technical Overview

Module 2: Traffic Forecasting
Methodologies
Data and Parameters, Step-by-Step Procedures, Examples

Module 3: Travel Demand Forecast Modeling
Model Selection, Checks and Refinements

Intended Audience
Forecast User
Traffic Forecaster/Modeler

Training Organization

Ohio Traffic Forecasting Training Modules
Module 1: Traffic Forecasting Background
Module 2: Traffic Forecasting Methodologies
Module 3: Travel Demand Forecast Modeling
OUTLINE - PART I

- Resources
- Data and Parameters
  - AADT Estimation
  - Peak Hour Selection
  - Balancing and Smoothing
  - Design Hour Factors
DOCUMENTATION AND COORDINATION

Throughout this training, the following symbols indicate:

- ![Document Icon] Items that are required or suggested for documentation
- ![People Icon] Items that are required or suggested for coordination with ODOT M&F
Projects that require Certified Design Traffic often involve multiple parties.

An **Early Coordination Meeting** is held to ensure that all parties agree on forecast scoping items to help avoid delays.

Many of the items to be resolved at that meeting involve the Travel Demand Modeling which will be discussed in the third course of this series.
RESOURCES
ODOT’s design traffic forecasting procedures are based on the techniques summarized in two documents from the National Cooperative Highway Research Program (NCHRP).

1. **NCHRP 255: Highway Traffic Data for Urbanized Area Project Planning and Design (NCHRP 255)**
   - Published in 1982
   - Documents the various techniques used by different state and local agencies to estimate future traffic volumes

2. **NCHRP 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design (NCHRP 765)**
   - Published in 2014
   - The primary travel demand forecasting documentation available to industry professionals
**FUNCTIONAL CLASSIFICATION MAPS**

Functional Classification is the grouping of roads in a hierarchy based on the type of highway service they provide.

**Functional Classification Maps** are provided at the county level for rural areas and in more detail for urban areas.

http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/MajorPrograms/Pages/RoadwayFunctionalClass.aspx
Office of Technical Services

The ODOT Office of Technical Services oversees all of the technical and geographic data collected by the Ohio Department of Transportation.

http://www.dot.state.oh.us/Divisions/Planning/TechServ/Pages/default.aspx
The Transportation Information Management System (TIMS) is a web-mapping portal for viewing the most current information on Ohio's transportation system, creating maps, and downloading GIS data.

- While it has traffic counts, these should be obtained from TMMS for project forecasting
- Traffic growth rates can be obtained here for TIS

https://gis.dot.state.oh.us/tims
The Traffic Monitoring Management System (TMMS or MS2) is a web-portal that provides access to short-term and continuous count data throughout the state.

http://odot.ms2soft.com/
The ODOT Office of Technical Services, Traffic Monitoring Section is specifically responsible for collecting, analyzing, and reporting traffic monitoring data.

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/default.aspx
The Hourly Percent by Vehicle Type Report gives the percentage of car and truck traffic for each hour of the day by functional classification. Distributions are based on continuous and short-term count data collected throughout the state.

Used to expand partial day counts to ADT
The Seasonal Adjustment Factor Report summarizes how ADT data collected on a given day of the month compares to the AADT by functional classification. Factors are based on continuous count data collected throughout the state.

Used to estimate AADT from ADT

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/SeaAdjFctrs.aspx
The K&D Factor Report summarizes design designations for each active continuous count station.
The Modeling & Forecasting Section’s Certified Traffic Page has links to documents specifically related to traffic forecasting.

Including the Traffic Forecasting Manual and this training.

http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Pages/CertifiedTraffic.aspx
The Peak Hour to Design Hour Factor Report summarizes how counted peak hour volumes collected on a given day of the month compare to the design hour volume by functional classification. Factors are based on continuous count data collected throughout the state.

http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Pages/CertifiedTraffic.aspx
StreetLight Data

StreetLight Data is an analytics company that organizes and interprets anonymous location data to provide meaningful travel metrics with high spatial accuracy.

In 2017, ODOT completed the purchase of Statewide origin-destination data from StreetLight Data.

- Accessible to any public agency or University within Ohio
- Can be made available to consultants on a temporary basis, given permission from the Office of Roadway Engineering
- Data available from January 2014 to present

[https://www.streetlightdata.com/](https://www.streetlightdata.com/)
Streetlight Data

This data can be used for:

• Calculation of OD from place to place in the project area
• In particular, calculation of weave volumes
• Estimation of location specific seasonal adjustment factors
• Estimation of location specific $K_{30}$ factors
• Note, use of these last two items is not standard practice, there are various issues with these data and they should only be used in consultation with ODOT M&F for locations that may have unusual characteristics
DATA AND PARAMETERS
## Count Types

<table>
<thead>
<tr>
<th>Description</th>
<th>Link Counts</th>
<th>Intersection Turning Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous</td>
<td>Short-Term</td>
</tr>
<tr>
<td>Description</td>
<td>Permanently installed counters</td>
<td>Portable machine counters</td>
</tr>
<tr>
<td>Location(s)</td>
<td>Varies, as available in study area</td>
<td>All ramps, arterials, and collectors in the study area, unless AADT &lt; 1,000 vpd</td>
</tr>
<tr>
<td>Duration</td>
<td>Continuous</td>
<td>Minimum 24 hours, preferred 48 hours</td>
</tr>
<tr>
<td>Source(s)</td>
<td>ODOT TMMS/MS2 (if available)</td>
<td>ODOT TMMS/MS2, MPO, Project count program</td>
</tr>
</tbody>
</table>
Data Collection Guidelines

Follow the guidelines on the Modeling & Forecasting web page

- Count data no more than 3 years old
- 24 to 48 hour counts on all ramps, arterials, and collectors
- 8 to 12 hour counts for all intersection forecasts
- Classified by passenger car and truck
**FUNCTIONAL CLASSIFICATION OF ROADS**

The functional classification of a road defines its role in serving transportation demand. Roads of similar classification could be expected to serve similar traffic patterns (i.e. Interstate versus local road).

Selection of forecast factors and parameters is partially based on the functional classification.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Interstate</td>
</tr>
<tr>
<td>02</td>
<td>Freeway/Expressway</td>
</tr>
<tr>
<td>03</td>
<td>Other Principal Arterial</td>
</tr>
<tr>
<td>04</td>
<td>Minor Arterial</td>
</tr>
<tr>
<td>05</td>
<td>Major Collector</td>
</tr>
<tr>
<td>06</td>
<td>Minor Collector</td>
</tr>
<tr>
<td>07</td>
<td>Local</td>
</tr>
</tbody>
</table>
## Vehicle Classification

<table>
<thead>
<tr>
<th>Minimum Classification</th>
<th>FHWA Scheme F Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Cars (P&amp;A)</td>
<td>1</td>
<td>Motorcycles</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Passenger Cars</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Other Two-Axle, Four-Tire, Single-Unit Vehicles</td>
</tr>
<tr>
<td>Trucks (B&amp;C)</td>
<td>4 - 13</td>
<td>All other vehicles including buses and Three-Axle or more trucks</td>
</tr>
</tbody>
</table>

See Ohio Traffic Forecasting Manual for additional classification information and equivalencies.
DATA AND PARAMETERS

AADT Estimation
AADT Estimation

Model results, and thus traffic forecasts, are based on AADT volumes and then factored down to the design hour of the year.

AADT can only be truly calculated with a full year’s worth of count data. This data is not available for most segments --- AADT usually must be estimated.

\[ AADT = \frac{\text{Total Traffic, vehicles per year}}{365 \text{ days per year}} \]
Traffic Count Expansion

Intersection turning movement counts are nearly always partial day (less than 24-hour) counts. Partial day counts must first be expanded to estimate 24-hour (ADT) turning movement volumes.

\[
ADT = \text{Counted Volume} \times \text{Expansion Factor}
\]

AADT turning movement estimates are required for:
- Calculating the 8th highest hour factor used in signal warrants
- Verifying \( K_{30} \)-factors
- Inputs to NCHRP factoring procedures
Traffic Count Expansion

Hourly traffic distributions must be considered when selecting expansion factors.

- Traffic volumes not evenly distributed throughout the day
- AM and PM peak hour volumes account for majority of total daily traffic

Example Distribution of Hourly Traffic Volumes

AM Peak (6-10am) = 22% of ADT

PM Peak (3-7pm) = 32% of ADT

TMC covers 54% of ADT in only 8 hours (33% of day)
TRAFFIC COUNT EXPANSION

ODOT recommends machine counts on at least one approach of each intersecting road (in addition to TMC) for traffic count expansion.

If short-term data are not available, statewide average distributions may be used from the Hourly Percent by Vehicle Type Report.

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/HrlyPercent.aspx
SEASONAL ADJUSTMENT

AADT represents the average daily traffic over the entire year. ADT must be seasonally adjusted using the factors contained in the Seasonal Adjustment Factor Report.

\[ AADT = ADT \times \text{Seasonal Adjustment Factor} \]

Travel patterns and traffic volumes vary by season due to:
- School schedule
- Inclement weather
- Recreational land uses
- Others

If you have unusual seasonal patterns you might use StreetLight Data in consultation with M&F

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/SeaAdjFctrs.aspx
SEASONAL ADJUSTMENT

In this example to estimate AADT, ADT data are factored:

- Up by 10% for data collected in January
- Down by 5% for data collected in October

Example Distribution of Monthly ADTs
Current Reports

- Most recent Hourly Percent by Vehicle Type and Seasonal Adjustment Factor Reports are from the year prior
- Check ODOT Office of Technical Services, Traffic Monitoring Section for most recent reports

Vehicle Classification

- Different expansion factors for Cars (P&A) and Trucks (B&C)
- Same seasonal adjustment factors for both
ODOT has created a **Partial Count Factor Form** to estimate AADT turn movements from peak hour turning movement volumes.

The Partial Count Factor Form can be obtained by contacting ODOT M&F.
1. Enter background information (not used in calculations):
   - Date of count
   - Name of each leg
   - Functional classification of each leg

2. Enter total counted volume for each movement, separated by Cars (P&A) and Trucks (B&C)
3. Enter expansion factors for each movement
   - Different factors should be selected for Cars (P&A) and Trucks (B&C)
   - Usually the same factor for all movements on a given leg

4. Enter seasonal adjustment factors for each movement
   - Same factor is used for Cars (P&A) and Trucks (B&C)
   - Usually the same factor for all movements on a given leg
## Partial Count Factor Form Outputs

### P&A 24 HR

<table>
<thead>
<tr>
<th></th>
<th>120</th>
<th>180</th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>9260</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9400</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9360</td>
<td></td>
<td>430</td>
<td>1020</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1480</td>
<td></td>
</tr>
</tbody>
</table>

### B&C 24 HR

<table>
<thead>
<tr>
<th></th>
<th>10</th>
<th>20</th>
<th>0</th>
</tr>
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<tr>
<td>260</td>
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<td></td>
</tr>
<tr>
<td>240</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>0</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

### TOTAL ADT

<table>
<thead>
<tr>
<th></th>
<th>130</th>
<th>200</th>
<th>140</th>
</tr>
</thead>
<tbody>
<tr>
<td>9520</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9640</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9600</td>
<td></td>
<td>450</td>
<td>1040</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>1530</td>
<td></td>
</tr>
</tbody>
</table>

Ohio Traffic Forecasting Manual
Volume 2, Section 2.4
Queue Counts provide the number of vehicles within the queue upstream of the count location --- which equates to the unmet demand after an interval of time.

- Typical approach is to measure queue size at end of every 15-minute interval at start of downstream traffic signal’s next red phase
- Queue size (in vehicles) can be approximated by measuring queue length (in feet), assuming 20 feet/vehicle and accounting for number of lanes
## Queue Counts

<table>
<thead>
<tr>
<th>Time Interval End</th>
<th>Count Location</th>
<th>Queue Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:15 PM</td>
<td></td>
<td>(7 veh)</td>
</tr>
<tr>
<td>4:30 PM</td>
<td></td>
<td>(15 veh)</td>
</tr>
<tr>
<td>4:45 PM</td>
<td></td>
<td>(10 veh)</td>
</tr>
<tr>
<td>5:00 PM</td>
<td></td>
<td>(3 veh)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>(1) Counted Approach Volume</th>
<th>(2) Queue Size (veh) at End of Interval</th>
<th>(3) Queue Size (veh) at End of Preceding Interval</th>
<th>(4) = (2) - (3) Unmet Demand (veh)</th>
<th>(5) = (1) + (4) Approach Demand Volume (veh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4:00 - 4:15 PM</td>
<td>221</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td>228</td>
</tr>
<tr>
<td>4:15 - 4:30 PM</td>
<td>261</td>
<td>15</td>
<td>7</td>
<td>8</td>
<td>269</td>
</tr>
<tr>
<td>4:30 - 4:45 PM</td>
<td>238</td>
<td>10</td>
<td>15</td>
<td>(-5)</td>
<td>233</td>
</tr>
<tr>
<td>4:45 - 5:00 PM</td>
<td>190</td>
<td>3</td>
<td>10</td>
<td>(-7)</td>
<td>183</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>910</strong></td>
<td><strong>35</strong></td>
<td><strong>32</strong></td>
<td><strong>3</strong></td>
<td><strong>913</strong></td>
</tr>
</tbody>
</table>
DATA AND PARAMETERS

Peak Hour Selection
PEAK HOUR SELECTION

Time Periods
- Selected by reviewing 15-minute traffic count data
- The peak hour does not necessarily start on the hour (example: peak hour might be 4:15 PM - 5:15 PM)
- Typically at least two peaks are analyzed --- Weekday AM and PM
- Others
  - Weekday Midday Peak
  - Saturday Midday Peak
  - Saturday PM Peak

System Peak Hour
- Single system peak hour should be used when there is more than one intersection in the study area
- Reasons why peak hours may vary
  - Nearby school or major traffic generator
  - Large study area
  - Long or heavily congested corridor
FACTORS TO CONSIDER

- What are the individual intersection peaks or primary roadway peaks?
- Are they close to the same time?
- Are most of them the same time?
- For those intersections that are not the same time, do they have wider peaks, such that it wouldn’t be significantly fewer vehicles to use a different Peak Hour?
- What is the peak hour for the intersections with the highest overall volume?
- Large study areas can have different peak hours in different subregions
**EXAMPLE: PEAK HOUR SELECTION**

<table>
<thead>
<tr>
<th>Intersection No.</th>
<th>Count Date</th>
<th>Total Entering Volume (vph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7:00-8:00 AM</td>
</tr>
<tr>
<td>1</td>
<td>4/14/16</td>
<td>1,156</td>
</tr>
<tr>
<td>2</td>
<td>9/26/16</td>
<td>1,258</td>
</tr>
<tr>
<td>3</td>
<td>9/26/16</td>
<td>1,163</td>
</tr>
<tr>
<td>4</td>
<td>9/07/16</td>
<td>1,283</td>
</tr>
<tr>
<td>5</td>
<td>4/20/16</td>
<td>1,521</td>
</tr>
<tr>
<td>6</td>
<td>9/26/16</td>
<td>1,323</td>
</tr>
<tr>
<td>7</td>
<td>9/26/16</td>
<td>1,289</td>
</tr>
<tr>
<td>8</td>
<td>9/26/16</td>
<td>1,328</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,321</strong></td>
<td><strong>10,620</strong></td>
</tr>
</tbody>
</table>
Inconsistencies between traffic volume data at two nearby locations may exist for multiple reasons including:

- Intersecting roadways between locations
- Differing growth rates
- Variation in count dates
- Variation in counter equipment clocks
- Counter error

If the traffic volumes should be consistent between locations, the forecaster must manually adjust traffic counts/forecasts.

Balancing and Smoothing are processes by which inconsistencies in traffic volume data at two nearby locations (data points) are reduced or eliminated.
**Difference Between Balancing and Smoothing**

**Balancing** is used to completely eliminate the traffic volume difference between locations (e.g. between ramp intersections at interchange).

**Smoothing** is used to reduce the traffic volume difference between locations to a reasonable level as determined by the forecaster (e.g. two intersections with a low-activity driveway in between).
EXAMPLE APPLICATIONS

Balancing Application:
- No driveways between intersections to account for loss/gain of traffic volumes

Smoothing Application:
- Small parking lot between intersections

Private access with 30-space parking lot
Balancing/smoothing is not always required.

Unbalanced volumes on traffic forecast plates should be indicated with a “break” symbol.
### Suggested Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split the Difference</td>
<td>Add half of the total link imbalance to the lower volume intersection and subtract the remainder of the total link imbalance to the higher volume intersection.</td>
<td>Realistic results</td>
<td>Time consuming, especially if multiple intersections</td>
</tr>
<tr>
<td>Higher Volume Distributed</td>
<td>Add total link imbalance to the lower volume intersection, distributed amongst all turning movements.</td>
<td>Realistic results</td>
<td>Time consuming</td>
</tr>
<tr>
<td>Higher Volume Through</td>
<td>Add total link imbalance to the through movement at the lower volume intersection.</td>
<td>Ease of calculations</td>
<td>Unrealistic results</td>
</tr>
<tr>
<td>NCHRP Link Volume Forcing</td>
<td>Use the link volume forcing option of the NCHRP 255 spreadsheet to automatically balance/smooth volume. Use with caution.</td>
<td>Automated calculations</td>
<td>May not produce desired results</td>
</tr>
<tr>
<td>Combination</td>
<td>Combination of all or some of the other methods.</td>
<td>Realistic results</td>
<td>Time consuming</td>
</tr>
</tbody>
</table>
General Steps

1. Identify breaks caused by long distances and/or major traffic generators between traffic forecast locations, where balancing/smoothing is not required.

2. Identify a logical starting point for balancing/smoothing efforts.
   - Typically the edge of the study area, proceeding in order
   - Could also be a major intersection, proceeding outward

   - Can be different from location to location

4. Check that balancing/smoothing has not reduced traffic forecast volumes to a value that is lower than the existing count (unless justification exists).
Use knowledge of the project area and professional judgment when manually adjusting traffic volumes.

Consider growth rates and K-factors when increasing traffic volumes to achieve balancing/smoothing.
Balancing/Smoothing Existing Volume Sets

- Do not always require balancing/smoothing (to be determined at Early Coordination Meeting)
- Balanced/smoothed existing volume set may reduce the effort required to balance/smooth design traffic forecast
- Existing volume set should always be checked for large discrepancies between intersection counts, regardless of actual balancing/smoothing efforts.
**Example:**

**Balancing Intersection Volumes**

**Objective**
- Rectify link volume imbalances between two intersections

**Given**
- Two (2) intersections on Cincinnati-Dayton Road in Liberty Township, OH
- Forecasted design hour traffic volumes
Example: Option 1

Split the Difference Method

1. Split the directional link imbalances equally between intersections.

Northbound Split:

\[
\frac{210 \text{ vph}}{2 \text{ intersections}} = 105 \text{ vph/intersection}
\]

- Add 110 vph to Intersection #1
- Subtract 100 vph from Intersection #2

Southbound Split:

\[
\frac{150 \text{ vph}}{2 \text{ intersections}} = 75 \text{ vph/intersection}
\]

- Add 80 vph to Intersection #1
- Subtract 70 vph from Intersection #2
EXAMPLE: OPTION 1

SPLIT THE DIFFERENCE METHOD

2. Proportion the northbound link imbalance amongst the contributing turning movements.

a. Add 110 vph to Intersection #1

**#1 Northbound Left:**
\[
\frac{790 \text{ vph}}{3,510 \text{ vph}} \times 110 \text{ vph} = 25 \text{ vph} \rightarrow 20 \text{ vph}
\]

**#1 Northbound Through:**
\[
\frac{1,590 \text{ vph}}{3,510 \text{ vph}} \times 110 \text{ vph} = 50 \text{ vph}
\]

**#1 Northbound Right:**
\[
\frac{1,130 \text{ vph}}{3,510 \text{ vph}} \times 110 \text{ vph} = 35 \text{ vph} \rightarrow 40 \text{ vph}
\]

**Check:**
\[
20 \text{ vph} + 50 \text{ vph} + 40 \text{ vph} = 110 \text{ vph} \quad \text{OK}
\]
Example: Option 1

Split the Difference Method

2. Proportion the **northbound** link imbalance amongst the contributing turning movements.

b. Subtract 100 vph from Intersection #2

**#2 Northbound Through:**

\[
\frac{2,450 \text{ vph}}{3,720 \text{ vph}} \times 100 \text{ vph} = 66 \text{ vph} \rightarrow 70 \text{ vph}
\]

**#2 Westbound Right:**

\[
\frac{1,270 \text{ vph}}{3,720 \text{ vph}} \times 100 \text{ vph} = 34 \text{ vph} \rightarrow 30 \text{ vph}
\]

**Check:**

\[
70 \text{ vph} + 30 \text{ vph} = 100 \text{ vph} \quad \text{OK}
\]
3. Proportion the **southbound** link imbalance amongst the contributing turning movements.
   
a. Add 80 vph to Intersection #1

   **#1 Westbound Left:**
   \[
   \frac{1,030 \text{ vph}}{2,610 \text{ vph}} \times 80 \text{ vph} = 32 \text{ vph} \rightarrow 30 \text{ vph}
   \]

   **#1 Southbound Through:**
   \[
   \frac{1,070 \text{ vph}}{2,610 \text{ vph}} \times 80 \text{ vph} = 33 \text{ vph} \rightarrow 30 \text{ vph}
   \]

   **#1 Eastbound Right:**
   \[
   \frac{510 \text{ vph}}{2,610 \text{ vph}} \times 80 \text{ vph} = 16 \text{ vph} \rightarrow 20 \text{ vph}
   \]

   **Check:**
   \[
   30 \text{ vph} + 30 \text{ vph} + 20 \text{ vph} = 80 \text{ vph} \quad \text{OK}
   \]
EXAMPLE: OPTION 1
SPLIT THE DIFFERENCE METHOD

3. Proportion the **southbound** link imbalance amongst the contributing turning movements.
   
b. Subtract 70 vph from Intersection #2

   **#2 Southbound Through:**
   \[
   \frac{2,210 \text{ vph}}{2,760 \text{ vph}} \times 70 \text{ vph} = 56 \text{ vph} \rightarrow 60 \text{ vph}
   \]

   **#2 Southbound Right:**
   \[
   \frac{550 \text{ vph}}{2,760 \text{ vph}} \times 70 \text{ vph} = 14 \text{ vph} \rightarrow 10 \text{ vph}
   \]

   **Check:**
   \[60 \text{ vph} + 10 \text{ vph} = 70 \text{ vph} \quad \text{OK}\]
EXAMPLE: OPTION 1

SPLIT THE DIFFERENCE METHOD

4. Add the calculated turning movement adjustments to each movement.
Example: Option 2
Higher Volume Distributed

1. Identify which intersection needs to be increased to rectify the imbalance in each direction of travel.

Northbound = Intersection #1
Southbound = Intersection #1
EXAMPLE: OPTION 2
HIGHER VOLUME DISTRIBUTED

2. Proportion the northbound link imbalance amongst the contributing turning movements.

#1 Northbound Left:
\[
\frac{790 \text{ vph}}{3,510 \text{ vph}} \times 210 \text{ vph} = 47 \text{ vph} \rightarrow 50 \text{ vph}
\]

#1 Northbound Through:
\[
\frac{1,590 \text{ vph}}{3,510 \text{ vph}} \times 210 \text{ vph} = 95 \text{ vph} \rightarrow 90 \text{ vph}
\]

#1 Northbound Right:
\[
\frac{1,130 \text{ vph}}{3,510 \text{ vph}} \times 210 \text{ vph} = 67 \text{ vph} \rightarrow 70 \text{ vph}
\]

Check:
\[
50 \text{ vph} + 90 \text{ vph} + 70 \text{ vph} = 210 \text{ vph} \quad \text{OK}
\]
3. Proportion the southbound link imbalance amongst the contributing turning movements.

**#1 Westbound Left:**
\[
\frac{1,030 \text{ vph}}{2,610 \text{ vph}} \times 150 \text{ vph} = 59 \text{ vph} \rightarrow 60 \text{ vph}
\]

**#1 Southbound Through:**
\[
\frac{1,070 \text{ vph}}{2,610 \text{ vph}} \times 150 \text{ vph} = 61 \text{ vph} \rightarrow 60 \text{ vph}
\]

**#1 Eastbound Right:**
\[
\frac{510 \text{ vph}}{2,610 \text{ vph}} \times 150 \text{ vph} = 29 \text{ vph} \rightarrow 30 \text{ vph}
\]

**Check:**
\[
60 \text{ vph} + 60 \text{ vph} + 30 \text{ vph} = 150 \text{ vph} \quad \text{OK}
\]
EXAMPLE: OPTION 2
HIGHER VOLUME DISTRIBUTED

4. Add the calculated turning movement adjustments to each movement.
Example: Option 3
Higher Volume Through

1. Identify which intersection needs to be increased to rectify the imbalance in each direction of travel (Intersection #1, both directions).

2. Add the northbound and southbound link imbalances to the corresponding through movements.
EXAMPLE: METHOD COMPARISON

Split the Difference

Higher Volume Distributed

Higher Volume Through
DATA AND PARAMETERS

Design Hour Factors
DESIGN HOUR VOLUME

Traffic volumes vary from hour-to-hour and day-to-day. A design hour is selected for designing roadways.

The design hour volume (DHV) is the number of vehicles that travel through a segment of roadway during the design hour.

- Selected by considering an entire year’s worth of count data
- 30th Highest Hour Volume (30 HV) is the standard
- NOT the highest volume out of the year (over-design)
**Design Hour Factors**

Traffic forecasts are based on AADT and factored down to DHV using **design hour factors**.

- **K-factor (K):** ratio of DHV to AADT
  
  \[ K = \frac{DHV}{AADT} \]

- **Directional factor (D):** ratio of DDHV to total DHV
  
  \[ D = \frac{DDHV}{DHV} \]

Design hour factors are calculated using existing traffic count data and are applied to future year traffic forecasts.

- Relationship between DDHV, DHV, and AADT is relatively stable regardless of traffic growth
- If this assumption is not true, special modeling steps can be taken to forecast the change as determined at the Early Coordination Meeting
The AADT, and thus the design hour factors, can only be truly calculated from a full year’s worth of data.

Design hour factors usually must be estimated using one of the methods suggested by ODOT M&F.
# K-Factor Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Count Station</td>
<td>Calculate using available continuous count data in K&amp;D Factor Report</td>
<td>• True K-factor calculation</td>
<td>• Not available on most roads</td>
</tr>
<tr>
<td>(or ATR) Data</td>
<td></td>
<td>• No special data collection efforts</td>
<td></td>
</tr>
<tr>
<td>Statewide Average DHV Factor</td>
<td>Estimate from Peak Hour to Design Hour Factor Report</td>
<td>• No special data collection efforts</td>
<td>• Estimate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Retains facility peaking characteristics</td>
<td>• Not site-specific</td>
</tr>
<tr>
<td>Proxy K-Factor</td>
<td>Estimate from K&amp;D Factor Report</td>
<td>• No special data collection efforts</td>
<td>• Estimate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not site-specific</td>
<td>• Difficult to choose a good proxy</td>
</tr>
<tr>
<td>Project-Specific Long-</td>
<td>Calculate (or estimate) using newly collected long-term count</td>
<td>• True K&lt;sub&gt;30&lt;/sub&gt;-factor calculation</td>
<td>• Special data request</td>
</tr>
<tr>
<td>Term Count Data</td>
<td></td>
<td>• Not always full year’s worth of data</td>
<td></td>
</tr>
</tbody>
</table>
HOW TO DETERMINE K-FACTOR

1. Continuous Count Station (or ATR) Data

Directly use the design hour factors contained within the K&D Factor Report, if the facility has a continuous count station. The ODOT Traffic Monitoring Section has over 200 ATR stations throughout the state. Design hour factors are calculated for each station and are updated annually.

Ohio Department of Transportation
2016 K and D Factor Report

<table>
<thead>
<tr>
<th>Loc #</th>
<th>Rural or Urban</th>
<th>FC Site</th>
<th>County</th>
<th>Route Type</th>
<th>Route</th>
<th>Log</th>
<th>HPMS</th>
<th>Date</th>
<th>Day of Week</th>
<th>Hour</th>
<th>% Daily Vol</th>
<th>% AADT K Factor</th>
<th>Dir</th>
<th>% Peak H-D Factor</th>
<th>% Daily Vol</th>
<th>% AADT</th>
<th>% Daily Vol</th>
<th>% AADT</th>
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<td>100002</td>
<td>U</td>
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<td>654</td>
<td>Muskingum</td>
<td>00271</td>
<td>IR</td>
<td>0.04</td>
<td>11/22/2016</td>
<td>Tuesday</td>
<td>25,105</td>
<td>31,142</td>
<td>124.05%</td>
<td>16</td>
<td>2,571</td>
<td>8.26%</td>
<td>10.24%</td>
<td>South</td>
<td>1,293</td>
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<tr>
<td>131</td>
<td>R</td>
<td>1</td>
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<td>Ashland</td>
<td>00071</td>
<td>IR</td>
<td>30.27</td>
<td>11/24/2016</td>
<td>Thursday</td>
<td>50,103</td>
<td>57,131</td>
<td>114.03%</td>
<td>12</td>
<td>5,613</td>
<td>9.82%</td>
<td>11.20%</td>
<td>North</td>
<td>3,353</td>
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<tr>
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<td>3</td>
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<td>Athens</td>
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<td>US</td>
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<td>11/27/2016</td>
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<td>10,936</td>
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<td>8/19/2016</td>
<td>Friday</td>
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<td>17</td>
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<td>3</td>
<td>509</td>
<td>Adams</td>
<td>00012</td>
<td>SR</td>
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<td>00005</td>
<td>IR</td>
<td>0.55</td>
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<td>6.39</td>
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<td>6/9/2016</td>
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<td>630</td>
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<td>4.7%</td>
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<td>7</td>
<td>8,264</td>
<td>9.73%</td>
<td>11.27%</td>
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<td>516</td>
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<td>10.32%</td>
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<tr>
<td>1259</td>
<td>R</td>
<td>4</td>
<td>163</td>
<td>Morrow</td>
<td>00012</td>
<td>US</td>
<td>22.29</td>
<td>10/8/2016</td>
<td>Friday</td>
<td>2,133</td>
<td>2,339</td>
<td>113.34%</td>
<td>16</td>
<td>242</td>
<td>10.09%</td>
<td>11.55%</td>
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<td>137</td>
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<td>IR</td>
<td>2.04</td>
<td>9/6/2016</td>
<td>Friday</td>
<td>107,764</td>
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<td>115.82%</td>
<td>7</td>
<td>11,109</td>
<td>8.61%</td>
<td>10.32%</td>
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<td>5,837</td>
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<td>1</td>
<td>134</td>
<td>Stark</td>
<td>00007</td>
<td>IR</td>
<td>11.81</td>
<td>6/1/2016</td>
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<td>103,647</td>
<td>122,967</td>
<td>108.09%</td>
<td>16</td>
<td>9,925</td>
<td>8.79%</td>
<td>9.18%</td>
<td>North</td>
<td>5,453</td>
</tr>
</tbody>
</table>

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/KnDFctrs.aspx
2. Statewide Average DHV Factors

Use the factors in the Peak Hour to Design Hour Factor Report to estimate the DHV, and subsequently $K_{30}$-factor, from the counted peak hour volume.

$$K_{30} = \frac{DHV}{AADT} = \frac{\text{Peak Hour Volume} \times \text{DHV Factor}}{AADT}$$

http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Pages/CertifiedTraffic.aspx
3. **Proxy $K_{30}$-Factor**

Use the information in the *K&D Factor Report* to identify facilities with similar characteristics, and assume a “Proxy” $K_{30}$-factor.

a. Identify one or multiple facilities from the *K&D Factor Report* with similar characteristics to the facility in question:
   - Functional classification
   - Area type, urban, suburban, small city or rural
   - Magnitude of AADT
   - Others
HOW TO DETERMINE K-FACTOR

3. Proxy $K_{30}$-Factor

b. Select a “Proxy” $K_{30}$-factor, typically using the average $K$-factor of all similar facilities.

c. Calculate the DHV Factor using the highest counted peak hour volume, the AADT estimated from the count, and the Proxy $K_{30}$-factor.

$$DHV\ Factor = \frac{Proxy\ K_{30} \times AADT_{site}}{Counted\ Peak\ Hour\ Volume_{site}}$$

d. Check the Proxy $K$ against site-specific data
   - If DHV Factor $\geq 1$, OK to use selected Proxy $K_{30}$-factor
   - If DHV Factor $< 1$, use Statewide Average DHV Method, or

$$K_{count} = \frac{Counted\ Peak\ Hour\ Volume_{site}}{AADT_{site}}$$
4. Project-Specific Long-Term Count Data

Contact the Office of Technical Services to install a project-specific Continuous Count Station if the available $K_{30}$-factor sources are not sufficient.

- Need determined at the Early Coordination Meeting
- Preferable to obtain an entire year’s worth of data, if timeline permits
- $K_{30}$-factor can be estimated from less than a year of data
- About 2 months of lead time required to install
**How to Determine $K_{30}$-Factor**

If no long-term or continuous count data is available, both the Statewide Average DHV Factor method and the Proxy $K_{30}$-Factor method should be checked.

- Statewide Average DHV Factor is preferable --- retains facility peaking characteristics
- Proxy $K_{30}$-factor assumes peaking characteristics of other facilities
EXAMPLE: SELECTING A $K_{30}$-FACTOR USING STATEWIDE AVERAGE DHV METHOD

Estimated AADT Turning Movements

North Leg:

$$K_{\text{Count}, N} = \frac{1,425 + 2,128}{22,170 + 22,580} \times 100\% = 8.1\%$$

$$K_{30} = 8.1\% \times 1.12 = 9.1\%$$

Ohio Traffic Forecasting Manual
Volume 2, Section 2.7
HOW TO DETERMINE D-FACTOR

1. Continuous Count Station (or ATR) Data for the actual facility as found in the K&D Factor Report
2. Peak Hour Data
3. Data from similar facilities contained in the K&D Factor Report (Similar to Proxy K\textsubscript{30}-factor)
4. Project-Specific Long-Term Count Data

\[ D = \frac{DDHV}{DHV} \]

http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/KnDFctrs.aspx
The directional distribution of traffic remains fairly consistent even as peak hour volumes fluctuate.

- Using D-factor calculated from existing peak hour data is suitable for applications to future years
- New facilities, new access points, or changes to the area land use result in different D-factors than existing which will come from the modeling
**Example: Calculate D-Factor From Peak Hour Data**

North Leg:

\[ D_N = \frac{2,128}{1,425 + 2,128} = 0.60 \]
**TYPICAL RANGES**

$K_{30}$-factors are usually in the range of 7-15%.

- Facilities of higher functional classification (i.e. freeways and arterials) typically have lower $K_{30}$-factors.
- Facilities of lower functional classification (i.e. local roads) may have higher $K_{30}$-factors.

D-factors are usually 55-60% but may be greater for corridors that experience extreme peak flows.
The types of land use being served by the facility can have a major impact on design hour factors.

- Mixed land uses usually produce $K_{30}$-factors and D-factors that are within typical ranges.
- Schools, recreational areas and factories oftentimes yield atypical (higher than typical) $K_{30}$-factors and D-factors.
EXERCISE
Data Processing
EXERCISE #1: DATA PROCESSING

Certified Design Traffic has been requested for three (3) intersections. The study area is pictured below and includes a diamond interchange and an adjacent T-intersection. The Project Opening Year is 2020 and the Design Year is 2040.
EXERCISE #1: DATA PROCESSING

Open the following spreadsheet:
Vol 2 Ex #1 - Data Processing.xlsx

This exercise will cover the data processing efforts required prior to developing the forecast. It is split into four parts:

1. Peak Hour Selection
2. AADT Estimation
3. $K_{30}$-Factor Selection
4. Diamond Interchange Conversion
EXERCISE #1: DATA PROCESSING

Tab #1: Peak Hour Selection

The table contains a summary of PM peak hour traffic volumes (total entering) for the three intersections. Using this data, select the peak hour volume for each intersection and the total system.

<table>
<thead>
<tr>
<th>Intersection Number</th>
<th>Total Entering Volume (vph)</th>
<th>Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4:00 PM - 5:00 PM</td>
<td>4:15 PM - 5:15 PM</td>
</tr>
<tr>
<td>1</td>
<td>3,169</td>
<td>3,311</td>
</tr>
<tr>
<td>2</td>
<td>3,074</td>
<td>3,131</td>
</tr>
<tr>
<td>3</td>
<td>1,627</td>
<td>1,682</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7,870</strong></td>
<td><strong>8,124</strong></td>
</tr>
</tbody>
</table>
EXERCISE #1: DATA PROCESSING

Tab #1: Peak Hour Selection

The table contains a summary of PM peak hour traffic volumes (total entering) for the three intersections. Using this data, select the peak hour volume for each intersection and the total system.

<table>
<thead>
<tr>
<th>Intersection Number</th>
<th>Total Entering Volume (vph)</th>
<th>Peak Hour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4:00 PM - 5:00 PM</td>
<td>4:15 PM - 5:15 PM</td>
</tr>
<tr>
<td>1</td>
<td>3,169</td>
<td>3,311</td>
</tr>
<tr>
<td>2</td>
<td>3,074</td>
<td>3,131</td>
</tr>
<tr>
<td>3</td>
<td>1,627</td>
<td>1,682</td>
</tr>
<tr>
<td>Total</td>
<td>7,870</td>
<td>8,124</td>
</tr>
</tbody>
</table>
EXERCISE #1: DATA PROCESSING

In this exercise, the peak hour window is relatively consistent from intersection to intersection. However, this is oftentimes not the case.

What things should be considered if there is no clear system peak hour?
EXERCISE #1: DATA PROCESSING

In this exercise, the peak hour window is relatively consistent from intersection to intersection. However, this is oftentimes not the case.

What things should be considered if there is no clear system peak hour?

- Highest volume intersection
- Interchange intersections
- Dates of counts
- Reasons peak hours should vary
EXERCISE #1: DATA PROCESSING

Tab #2: AADT Estimation

This tab shows the Partial Count Factor Form for Intersection #1 (southbound ramps). Inputs have been completed for the north leg of the intersection.

Use the Hourly Percent by Vehicle Type Report to calculate the expansion factor for P&A Vehicles (Cars) on US Route B.
### EXERCISE #1: DATA PROCESSING

**Ohio Traffic Forecasting Manual**

#### Hours covered by turning movement count

<table>
<thead>
<tr>
<th>Hour</th>
<th>Hour of Day</th>
<th>P&amp;A (Cars)</th>
<th>% P&amp;A (Cars)</th>
<th>B&amp;C (Trucks)</th>
<th>% B&amp;C (Trucks)</th>
<th>Total</th>
<th>% Total</th>
</tr>
</thead>
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<td>0</td>
<td>12-1 am</td>
<td>430,823</td>
<td>0.6%</td>
<td>50,605</td>
<td>1.3%</td>
<td>481,428</td>
<td>0.6%</td>
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<tr>
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<td>1-2 am</td>
<td>249,138</td>
<td>0.3%</td>
<td>45,233</td>
<td>1.2%</td>
<td>294,371</td>
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<tr>
<td>2</td>
<td>2-3 am</td>
<td>216,334</td>
<td>0.3%</td>
<td>45,655</td>
<td>1.2%</td>
<td>261,989</td>
<td>0.3%</td>
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<td>3-4 am</td>
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<td>1.5%</td>
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<tr>
<td>4</td>
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<td>602,405</td>
<td>0.8%</td>
<td>82,742</td>
<td>2.1%</td>
<td>685,147</td>
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</tr>
<tr>
<td>5</td>
<td>5-6 am</td>
<td>1,608,045</td>
<td>2.1%</td>
<td>127,321</td>
<td>3.3%</td>
<td>1,735,366</td>
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</tr>
<tr>
<td>6</td>
<td>6-7 am</td>
<td>3,137,960</td>
<td>4.1%</td>
<td>184,775</td>
<td>4.8%</td>
<td>3,322,735</td>
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</tr>
<tr>
<td>7</td>
<td>7-8 am</td>
<td>4,741,805</td>
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<td>4,968,224</td>
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</tr>
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<td>8</td>
<td>8-9 am</td>
<td>4,319,076</td>
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<td>246,230</td>
<td>6.4%</td>
<td>4,565,306</td>
<td>5.7%</td>
</tr>
<tr>
<td>9</td>
<td>9-10 am</td>
<td>3,863,131</td>
<td>5.0%</td>
<td>259,872</td>
<td>6.7%</td>
<td>4,123,003</td>
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<td>10</td>
<td>10-11 am</td>
<td>3,976,302</td>
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<td>7.0%</td>
<td>4,244,773</td>
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<tr>
<td>11</td>
<td>11-12 am</td>
<td>4,445,816</td>
<td>5.8%</td>
<td>270,460</td>
<td>7.0%</td>
<td>4,716,276</td>
<td>5.8%</td>
</tr>
<tr>
<td>12</td>
<td>12-1 pm</td>
<td>4,755,576</td>
<td>6.2%</td>
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<td>6.9%</td>
<td>5,021,681</td>
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</tr>
<tr>
<td>13</td>
<td>1-2 pm</td>
<td>4,846,186</td>
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<td>261,709</td>
<td>6.8%</td>
<td>5,107,895</td>
<td>6.3%</td>
</tr>
<tr>
<td>14</td>
<td>2-3 pm</td>
<td>5,326,532</td>
<td>6.9%</td>
<td>261,175</td>
<td>6.8%</td>
<td>5,587,707</td>
<td>6.9%</td>
</tr>
<tr>
<td>15</td>
<td>3-4 pm</td>
<td>6,041,866</td>
<td>7.9%</td>
<td>242,551</td>
<td>6.3%</td>
<td>6,284,417</td>
<td>7.8%</td>
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<tr>
<td>16</td>
<td>4-5 pm</td>
<td>6,446,308</td>
<td>8.4%</td>
<td>211,727</td>
<td>5.5%</td>
<td>6,658,035</td>
<td>8.2%</td>
</tr>
<tr>
<td>17</td>
<td>5-6 pm</td>
<td>6,282,696</td>
<td>8.2%</td>
<td>174,520</td>
<td>4.5%</td>
<td>6,457,216</td>
<td>8.0%</td>
</tr>
<tr>
<td>18</td>
<td>6-7 pm</td>
<td>4,648,252</td>
<td>6.0%</td>
<td>138,920</td>
<td>3.6%</td>
<td>4,787,172</td>
<td>5.9%</td>
</tr>
<tr>
<td>19</td>
<td>7-8 pm</td>
<td>3,472,024</td>
<td>4.5%</td>
<td>115,042</td>
<td>3.0%</td>
<td>3,587,065</td>
<td>4.4%</td>
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<tr>
<td>20</td>
<td>8-9 pm</td>
<td>2,764,628</td>
<td>3.6%</td>
<td>96,655</td>
<td>2.6%</td>
<td>2,863,283</td>
<td>3.5%</td>
</tr>
<tr>
<td>21</td>
<td>9-10 pm</td>
<td>2,054,169</td>
<td>2.7%</td>
<td>83,436</td>
<td>2.2%</td>
<td>2,137,605</td>
<td>2.7%</td>
</tr>
<tr>
<td>22</td>
<td>10-11 pm</td>
<td>1,400,479</td>
<td>1.8%</td>
<td>73,524</td>
<td>1.9%</td>
<td>1,474,003</td>
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</tr>
<tr>
<td>23</td>
<td>11-12 pm</td>
<td>905,442</td>
<td>1.2%</td>
<td>63,840</td>
<td>1.7%</td>
<td>969,282</td>
<td>1.2%</td>
</tr>
</tbody>
</table>

**Total**

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>76,879,007</td>
<td>100%</td>
<td>3,855,394</td>
<td>100%</td>
<td>80,734,401</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \sum P&A = 20.9\% = 0.209 \]

\[ \sum B&C = 30.5\% = 0.305 \]

**P&A Expansion Factor = \( \frac{1}{0.209 + 0.305} \) = 1.946**
EXERCISE #1: DATA PROCESSING

Tab #2: AADT Estimation

Select the seasonal adjustment factor for US Route B using the Seasonal Adjustment Factor Report.

The intersection was counted on Thursday, April 19, 2018.
EXERCISE #1: DATA PROCESSING

Tab #2: AADT Estimation

Select the seasonal adjustment factor for US Route B using the Seasonal Adjustment Factor Report.

The intersection was counted on Thursday, April 19, 2018.
EXERCISE #1: DATA PROCESSING

Tab #2: AADT Estimation

Input the P&A Factor and Seasonal Adjustment Factor for the east and west legs (US Route B) into the Partial Count Factor Form.

Note the inputs for the B&C Vehicles (Trucks) and how they differ from the P&A Vehicles. The calculated AADTs are located at the bottom of the page.
EXERCISE #1: DATA PROCESSING

Tab #2: AADT Estimation

Input the P&A Factor and Seasonal Adjustment Factor for the east and west legs (US Route B) into the Partial Count Factor Form.

Note the inputs for the B&C Vehicles (Trucks) and how they differ from the P&A Vehicles. The calculated AADTs are located at the bottom of the page.
**EXERCISE #1: DATA PROCESSING**

**Tab #3: K-Factor Selection**

The table contains a summary of the traffic volumes on each leg of Intersection #1. Note how the AADT values match the results from Tab #2.

Use the data to calculate \( K_{\text{Count}} \) for the east leg.
EXERCISE #1: DATA PROCESSING

Tab #3: K-Factor Selection

The table contains a summary of the traffic volumes on each leg of Intersection #1. Note how the AADT values match the results from Tab #2.

Use the data to calculate $K_{Count}$ for the east leg.

$$K_{Count} = \frac{2,501}{26,080} \times 100\% = \boxed{9.6\%}$$
**EXERCISE #1: DATA PROCESSING**

Tab #3: $K_{30}$-Factor Selection

Use the **Peak Hour to Design Hour Factor Report** to identify the DHV Factor.

---

**PEAK HOUR to DESIGN HOUR FACTORS**

*FUNCTIONAL CLASSIFICATION = 03, 04, 05u*  
(Urban Principal Arterial, Urban Minor Arterial, & Urban Minor Collector)

<table>
<thead>
<tr>
<th>Month</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.20</td>
<td>1.18</td>
<td>1.16</td>
<td>1.11</td>
<td>1.09</td>
<td>1.15</td>
<td>1.17</td>
<td>1.14</td>
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<td></td>
<td>1.70</td>
<td>1.58</td>
<td>1.58</td>
<td>1.50</td>
<td>1.45</td>
<td>1.49</td>
<td>1.53</td>
<td>1.50</td>
<td>1.52</td>
<td>1.52</td>
<td>1.56</td>
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<tr>
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<td>1.17</td>
<td>1.14</td>
<td>1.11</td>
<td>1.17</td>
<td>1.20</td>
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<td>1.15</td>
<td>1.16</td>
<td>1.15</td>
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<td>1.18</td>
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<td>1.12</td>
<td>1.12</td>
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<td>1.15</td>
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<td>1.16</td>
<td>1.09</td>
<td>1.08</td>
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<td>1.14</td>
<td>1.13</td>
<td>1.13</td>
<td>1.13</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>1.18</td>
<td>1.17</td>
<td>1.14</td>
<td>1.10</td>
<td>1.07</td>
<td>1.12</td>
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<td>1.12</td>
<td>1.12</td>
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</tr>
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<td></td>
<td>1.14</td>
<td>1.10</td>
<td>1.11</td>
<td>1.07</td>
<td>1.04</td>
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<td>1.16</td>
<td>1.14</td>
<td>1.12</td>
<td>1.12</td>
<td>1.10</td>
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<td>1.10</td>
<td>1.11</td>
<td>1.09</td>
<td>1.04</td>
<td>1.12</td>
<td>1.16</td>
<td>1.14</td>
<td>1.12</td>
<td>1.12</td>
<td>1.10</td>
<td>1.09</td>
</tr>
</tbody>
</table>

**Intersection counted on Thursday, April 19, 2018.**
**Exercise #1: Data Processing**

Tab #3: $K_{30}$-Factor Selection

---

### Peak Hour to Design Hour Factors

*Functional Classification = 03, 04, 05u*  
(Urban Principal Arterial, Urban Minor Arterial, & Urban Minor Collector)

#### Monthly Average by Day-of-Week

<table>
<thead>
<tr>
<th>Month</th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1.20</td>
<td>1.70</td>
<td>1.21</td>
<td>1.21</td>
<td>1.19</td>
<td>1.18</td>
<td>1.14</td>
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<td>1.17</td>
<td>1.16</td>
<td>1.16</td>
<td>1.14</td>
<td>1.11</td>
</tr>
<tr>
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<td>1.50</td>
<td>1.14</td>
<td>1.11</td>
<td>1.09</td>
<td>1.10</td>
<td>1.07</td>
</tr>
<tr>
<td>May</td>
<td>1.09</td>
<td>1.45</td>
<td>1.11</td>
<td>1.10</td>
<td>1.08</td>
<td>1.07</td>
<td>1.04</td>
</tr>
<tr>
<td>June</td>
<td>1.15</td>
<td>1.49</td>
<td>1.17</td>
<td>1.15</td>
<td>1.14</td>
<td>1.12</td>
<td>1.09</td>
</tr>
<tr>
<td>July</td>
<td>1.17</td>
<td>1.53</td>
<td>1.20</td>
<td>1.18</td>
<td>1.17</td>
<td>1.16</td>
<td>1.13</td>
</tr>
<tr>
<td>August</td>
<td>1.14</td>
<td>1.50</td>
<td>1.16</td>
<td>1.15</td>
<td>1.13</td>
<td>1.12</td>
<td>1.09</td>
</tr>
<tr>
<td>September</td>
<td>1.12</td>
<td>1.52</td>
<td>1.15</td>
<td>1.12</td>
<td>1.13</td>
<td>1.09</td>
<td>1.04</td>
</tr>
<tr>
<td>October</td>
<td>1.11</td>
<td>1.52</td>
<td>1.14</td>
<td>1.10</td>
<td>1.10</td>
<td>1.09</td>
<td>1.05</td>
</tr>
<tr>
<td>November</td>
<td>1.12</td>
<td>1.56</td>
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<td>1.12</td>
<td>1.13</td>
<td>1.10</td>
<td>1.05</td>
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<td>1.15</td>
<td>1.13</td>
<td>1.13</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Intersection counted on Thursday, April 19, 2018.
EXERCISE #1: DATA PROCESSING

Tab #3: $K_{30}$-Factor Selection

Input the selected DHV Factor, and the calculated $K_{\text{Count}}$, into the table and calculate the new $K_{30}$.

<table>
<thead>
<tr>
<th>Intersection Leg</th>
<th>PM Peak Hour Volume (vph)</th>
<th>AADT (vpd)</th>
<th>$K_{\text{Count}}$</th>
<th>DHV Factor</th>
<th>$K$</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>2,501</td>
<td>26,080</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>2,962</td>
<td>32,520</td>
<td>9.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>312</td>
<td>3,110</td>
<td>10.0%</td>
<td>1.09</td>
<td>10.9%</td>
</tr>
</tbody>
</table>
**EXERCISE #1: DATA PROCESSING**

Tab #3: $K_{30}$-Factor Selection

Input the selected DHV Factor, and the calculated $K_{\text{Count}}$, into the table and calculate the new $K_{30}$.

---

### Estimated K-Factors, Statewide Average DHV Factor Method

<table>
<thead>
<tr>
<th>Intersection Leg</th>
<th>PM Peak Hour Volume (vph)</th>
<th>AADT (vpd)</th>
<th>$K_{\text{Count}}$</th>
<th>DHV Factor</th>
<th>$K$</th>
</tr>
</thead>
<tbody>
<tr>
<td>East</td>
<td>2,501</td>
<td>26,080</td>
<td>9.6%</td>
<td>1.10</td>
<td>10.6%</td>
</tr>
<tr>
<td>West</td>
<td>2,962</td>
<td>32,520</td>
<td>9.1%</td>
<td>1.10</td>
<td>10.0%</td>
</tr>
<tr>
<td>North</td>
<td>312</td>
<td>3,110</td>
<td>10.0%</td>
<td>1.09</td>
<td>10.9%</td>
</tr>
</tbody>
</table>

$K_{30} = 9.6\% \times 1.10 = 10.6\%$

$K_{30} = 9.1\% \times 1.10 = 10.0\%$

---

*Use DHV Factor directly for forecast.*

---

Ohio Traffic Forecasting Manual
**Exercise #1: Data Processing**

Open the following spreadsheet: 
*KandD_Factors_17_HPMS_FC Sort.pdf*

If Interstate A is an urban interstate and the AADT is approximately 90,000 vpd, select a Proxy $K_{30}$-Factor from the *K&D Factor Report.*
EXERCISE #1: DATA PROCESSING

Open the following spreadsheet: *KandD_Factors_17_HPMS_FC Sort.pdf*

If Interstate A is an urban interstate and the AADT is approximately 90,000 vpd, select a Proxy $K_{30}$-Factor from the K&D Factor Report.

Area type is urban, FC=1 (Interstate), AADT near 90,000 vpd. $K_{30}$-Factors from the K&D Report are in the range of 9.56-10.12%. Use $K_{30} = 10\%$ for Interstate A.
An interchange can be treated as one single intersection for forecasting purposes.

- Helps to ensure consistency between interchange movements
- Considers mainline interstate forecasts when developing the ramp forecasts

Example Conversion of Diamond Interchange to Four-Legged Intersection

It may not be possible to convert complex interchanges into one “intersection.”
EXERCISE #1: DATA PROCESSING

Tab #4: Diamond Interchange Conversion

The AADT volumes at the diamond interchange intersections (Intersections #1 and #2) can be converted into a single intersection for input into the spreadsheet tool. Doing so will help to simplify the post-processing of traffic forecasts.
EXERCISE #1: DATA PROCESSING
Tab #4: Diamond Interchange Conversion

Existing AADT
Diamond Interchange

Existing AADT
Single Intersection

Ohio Traffic Forecasting Manual
EXERCISE #1: DATA PROCESSING

Tab #4: Diamond Interchange Conversion